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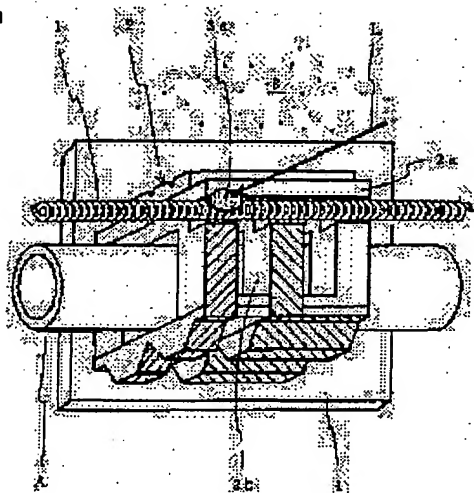
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(54) BONDING

(57)Abstract:

PURPOSE: To provide a new bonding method capable of bonding even a micro part of a nan order or less freely in a three-dimensional way.

CONSTITUTION: Mutually bonding regions of parts intended to be mutually bonded, such as a shape memory member 1 of an actively bending mechanism to be supplied to a catheter and a connecting unit 2 are brought into contact with each other. A raw material gas 3 is deposited as a polymer 3a on the contact regions by using light CVD method to bond the bonding regions intended with the polymer 3a to provide the objective bonding method especially useful as a micro assembly. Preferably at least the contact regions of the bonding regions intended are cooled by using a Peltier element 4, etc., to such a low temperature as to condense the raw material gas. A continuous ultraviolet laser beam is preferably used in the light CVD method.



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CLAIMS

[Claim(s)]

[Claim 1] The junction method characterized by joining the parts which mean junction by contacting the parts which mean junction of the parts which should be joined, using optical CVD for this part that contacted, and making material gas deposit as polymer in the aforementioned polymer.

[Claim 2] The junction method according to claim 1 that the part which the parts which mean junction at least contacted is what is cooled by the low temperature which material gas can condense.

[Claim 3] The junction method according to claim 2 that cooling to the low temperature which material gas can condense is what is made by the Peltier element.

[Claim 4] The optical CVD's junction method according to claim 1 using a continuation ultraviolet-rays laser beam.

[Claim 5] The junction method according to claim 1 that material gas is vinyl acetate and the polymer to deposit is polyvinyl acetate.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the junction method useful to junction of the parts used for a minute machine etc. in detail about the junction method.

[0002]

[Description of the Prior Art] Micro machines (or micro mechanism) are a 1/hundreds of mm to about several mm micro machine, a machine element, and a robot, and are especially expected in fields, such as cell operation and medicine. In recent years, many micro parts which can use a micro sensor, an actuator, etc. for a micro machine are proposed. Microassembly technology is indispensable technology in order to assemble a micro machine from the minute component of these many. the part which it is important technology, and micro parts with the minute object of the junction are comrades in many cases a part, and is especially contacted for junction in order to assemble junction technology also in it -- the number of radius phi -- it may be so minute that it is included in an about 10-micrometer spherical virtual region And the-like 3-dimensional junction of back-joining etc. which inserted the junction of not only junction that is performed by sticking simple flat surfaces but two extra fine wires which contacts by one point and crosses, and the detailed and complicated configuration storage member in the crevice where housing is minute is also required mutually.

[0003]

[Problem(s) to be Solved by the Invention] Two-dimensional junction technology which is performed by sticking the above-mentioned simple flat surfaces is known as general technology like for example, anode plate junction. However, many troubles still exist in the technology for joining a minute machine element which amounts also to several micrometers in three dimensions below mm order. For example, there is an example by which the technology of stiffening ultraviolet-rays hardening resin locally using helium-Cd laser was applied to the assembly of a catheter as junction technology of micro parts. However, it is necessary to remove with a solvent the resin of the portion which was not hardened, and there is a possibility that micro parts may be damaged in that case, by this method. Moreover, it considers using the transplant technology of the device using the focused ion beam as junction technology of micro parts. This technology is the method of joining these with glue by making the portion which performs sputtering and means junction of micro parts by the focused ion beam deposit an atom. However, since this method requires time, it cannot be said as a practical method.

[0004] Even if the purpose of this invention solves the above-mentioned problem and are the micro parts below mm order, it is offering the new junction method which can be joined free in three dimensions.

[0005]

[Means for Solving the Problem] The junction method of this invention has the following features.

- (1) The junction method characterized by joining the parts which mean junction by contacting the parts which mean junction of the parts which should be joined, using optical CVD for this part that contacted, and making material gas deposit as polymer in the aforementioned polymer.
- (2) The junction method of the above-mentioned (1) publication that the part which the parts which mean junction at least contacted is what is cooled by the low temperature which material gas can

condense.

(3) The junction method of the above-mentioned (2) publication that cooling to the low temperature which material gas can condense is what is made by the Peltier element.

(4) The junction method given in above-mentioned [optical CVD / using a continuation ultraviolet-rays laser beam] (1).

(5) The junction method of the above-mentioned (1) publication that material gas is vinyl acetate and the polymer to deposit is polyvinyl acetate.

[0006]

[Function] It is that it was newly shown that the optical CVD used as a thin film forming method in the former can use one of the important features of the junction method of this invention as the useful junction method especially in a microassembly as the junction method. By using optical CVD for the joint grade at which the parts which should be joined were contacted, and making the polymer for junction deposit on it, even if it is the local parts of minute parts, it becomes possible not to need a solvent etc. but to join in three dimensions. It becomes possible by using a continuation ultraviolet-rays laser beam to make polymer deposit at high speed as the excitation light source especially used for optical CVD. The wavelength of ultraviolet radiation is what is easy to be absorbed by the photochemical reactivity gas which is material gas, and this is because the continuation light is more efficient than pulsed light and a reaction is caused. Moreover, by cooling the joint grade mutually contacted in the process on which polymer is made to deposit by optical CVD, material gas condenses to a low-temperature part, and it becomes possible to make high speed deposit more of it.

[0007]

[Example] Hereafter, an example is given and this invention is further explained to a detail.

Example 1 drawing 1 is drawing showing one example of the junction method of this invention typically, and is shown as like [a part of] the assembler when giving an active incurvation mechanism to a catheter. the active incurvation mechanism of a catheter arranges a configuration storage member along with the longitudinal direction of this catheter in the position which divides the periphery of a catheter into plurality -- configuration storage -- expansion and contraction of a member are the mechanism in which it can act like muscular operation and a catheter can be made crooked free In this drawing, the configuration storage member of the shape of a coil which contracts A with the catheter of medical application and contracts 1 to a longitudinal direction by heating, and 2 are connection units fixed to the longitudinal direction of a catheter by setting a predetermined interval, in order to arrange the aforementioned configuration storage member along with a catheter. The connection unit used for this example is a minute part with an overall length of 3mm, and are the micro parts with which the laminating of a silicon layer and the glass layer was carried out by anode plate junction, and the layer of an electric conduction circuit as shown by hatching was formed in the front face like silicon layer 2a and glass layer 2b. The cross section of a catheter is circular and it is flexible tubing whose outer diameter is $\phi 1$ mm.

[0008] The junction method of this invention is explained according to the example of the junction process shown in drawing 1.

** . -- configuration storage to join -- carry out alignment of the parts which mean junction of the connection unit 2 to a member 1 using a micromanipulator etc.

** . The part circumference which means junction is filled with the material gas 3 of photochemical reactivity. Photochemical reactivity gas generates polymer by light.

** . It cools to the low temperature to which material gas can condense a portion to join using the Peltier element 4. This cooling is the desirable conditions for making polymer deposit more at high speed.

** . Continuation ultraviolet-rays (Continuous Wave Ultraviolet : CW UV) laser beam L is irradiated, and a portion to join is made to deposit polymer 3a.

** . -- deposited polymer 3a -- adhesives -- becoming -- configuration storage -- a member 1 and the connection unit 2 are joined in the deposition portion

[0009] Optical CVD is a vapor growth using the luminous energy, and is the forming-membranes method for exciting the electronic state and vibrational state of material gas, and promoting gaseous phase reaction. As the excitation light source of the optical CVD used for this invention, although

laser, a lamp, etc. can be used, power density of laser is high and it is the desirable excitation light source at the point that a beam diameter can be extracted to mum grade. Polymer can be made to deposit by using the ultraviolet radiation which is the wavelength which material gas tended to absorb at high speed, as the above-mentioned operation described especially. Furthermore, it is desirable to use the laser beam by the continuous oscillation which causes a reaction more efficiently than pulse laser light. as the laser equipment which may output a continuation ultraviolet-rays laser beam -- intra -- Ar+ of the second harmonic using cavity nonlinear optics Laser equipment, the YAG laser equipment of the fourth higher harmonic, etc. are mentioned.

[0010] Vinyl acetate, a methyl methacrylate, a methyl acrylate, an acrylaldehyde, etc. are mentioned that material gas should just be the thing of photochemical reactivity with possible making it deposit as polymer according to the process of optical CVD. Since a polymerization is suitably carried out as polyvinyl acetate and a quality deposit is obtained, especially vinyl acetate is the most desirable material.

[0011] It is the desirable conditions for making polymer deposit more at high speed to cool a portion to join to the low temperature which material gas can condense. As long as the cooling method is the method of cooling the part which means junction at least, it may be what method. For example, the method of maintaining the whole inside of a sealing tub for enforcing optical CVD at low temperature, the method of maintaining only joint grade at low temperature locally, etc. are mentioned. Since the Peltier element is especially arranged near the joint grade and temperature control can do the method of cooling only joint grade locally simply, it is desirable.

[0012] In this example, as a result of making it deposit on a part for a joint as polyvinyl acetate and investigating change of the temperature for a joint, and the rate of sedimentation by the laser power of a continuation ultraviolet-rays laser beam, using vinyl acetate as material gas, when 257nm and a laser power used the laser whose wavelength the temperature for a joint is 25mW at 6.5 degrees C, the maximum rate of sedimentation of about 10 micrometer/min was obtained. Moreover, when the intensity of junction to the configuration storage member and connection unit which were joined in this example was investigated, it turns out that it is possible to bear the force of the shaft orientations of maximum abbreviation 70mN.

[0013] Example 2 this example shows the example in the case of applying this invention to the assembly when giving other active incurvation mechanisms to a catheter. Drawing 2 is drawing in which it is typically shown like the erector of that. The active incurvation mechanism shown in this drawing is made into the structure where three wires for for the first time in [neck] are prepared in the circumference of a catheter, and do not pull these three wires for for the first time in [neck] directly from an operation side, but a wire is pulled by shrinking the configuration storage member made to intervene in between from an operation side in order to make the point of a catheter crooked free. this example is an example which joined this wire for for the first time in [neck], and the configuration storage member at the end. That is, the above-mentioned example is the junction which connects a line and a line with a detailed this example at the end to being three-dimensional junction in the minute portion of a field and a line.

[0014] The parts made into the object of junction are SUS304 and an outer-diameter phi30micrometer wire rod as a configuration storage member as a Ti-nickel system alloy, diameter phiof strand30micrometer, coil outer-diameter phi100micrometer, and a wire for for the first time in [neck]. When the intensity of this junction was investigated, it turns out that it is possible to bear the hauling force of maximum abbreviation 70mN.

[0015] Although the junction method of this invention can be used as the general junction method, when the parts which should be joined are minute parts which constitute a micro machine, the usefulness is most notably shown like this example.

[0016]

[Effect of the Invention] As mentioned above, the junction method of this invention can apply the optical CVD which is a thin film coating technology to junction, and can employ the detailed and precise drawing capacity of especially laser CVD in precise junction of minute parts efficiently. Moreover, since it is a dry process, in a junction process, there is no injury on the parts by the solvent etc. Moreover, it becomes possible by using a continuation ultraviolet-rays laser beam to join at high speed. Furthermore, by cooling the portion to join and making the portion condense material

gas, polymer can be deposited at a quicker speed and it can join to high speed more. Therefore, even if it was the micro parts below mm order, the new junction method which can be joined at high speed free in three dimensions was able to be offered.

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TECHNICAL FIELD

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PRIOR ART

[Description of the Prior Art] Micro machines (or micro mechanism) are a 1/hundreds of mm to about several mm micro machine, a machine element, and a robot, and are especially expected in fields, such as cell operation and medical treatment. In recent years, many micro parts which can use a micro sensor, an actuator, etc. for a micro machine are proposed. Microassembly technology is indispensable technology in order to assemble a micro machine from the minute component of these many. the part which it is important technology, and micro parts with the minute object of the junction are comrades in many cases a part, and is especially contacted for junction in order to assemble junction technology also in it — the number of radius phi — it may be so minute that it is included in an about 10-micrometer spherical virtual region And the-like 3-dimensional junction of back-joining etc. which inserted the junction of not only junction that is performed by sticking simple flat surfaces but two extra fine wires which contacts by one point and crosses, and the detailed and complicated configuration storage member in the crevice where housing is minute is also required mutually.

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EFFECT OF THE INVENTION

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Two-dimensional junction technology which is performed by sticking the above-mentioned simple flat surfaces is known as general technology like for example, anode plate junction. However, many troubles still exist in the technology for joining a minute machine element which amounts also to several micrometers in three dimensions below mm order. For example, there is an example by which the technology of stiffening ultraviolet-rays hardening resin locally using helium-Cd laser was applied to the assembly of a catheter as junction technology of micro parts. However, it is necessary to remove with a solvent the resin of the portion which was not hardened, and there is a possibility that micro parts may be damaged in that case, by this method. Moreover, it considers using the transplant technology of the device using the focused ion beam as junction technology of micro parts. This technology is the method of joining these with glue by making the portion which performs sputtering and means junction of micro parts by the focused ion beam deposit an atom. However, since this method requires time, it cannot be said as a practical method.

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MEANS

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OPERATION

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EXAMPLE

[Example] Hereafter, an example is given and this invention is further explained to a detail. Example 1 drawing 1 is drawing showing one example of the junction method of this invention typically, and is shown as like [a part of] the assembler when giving an active incurvation mechanism to a catheter. the active incurvation mechanism of a catheter arranges a configuration storage member along with the longitudinal direction of this catheter in the position which divides the periphery of a catheter into plurality -- configuration storage -- expansion and contraction of a member are the mechanism in which it can act like muscular operation and a catheter can be made crooked free. In this drawing, the configuration storage member of the shape of a coil which contracts A with the catheter of medical application and contracts 1 to a longitudinal direction by heating, and 2 are connection units fixed to the longitudinal direction of a catheter by setting a predetermined interval, in order to arrange the aforementioned configuration storage member along with a catheter. The connection unit used for this example is a minute part with an overall length of 3mm, and are the micro parts with which the laminating of a silicon layer and the glass layer was carried out by anode plate junction, and the layer of an electric conduction circuit as shown by hatching was formed in the front face like silicon layer 2a and glass layer 2b. The cross section of a catheter is circular and it is flexible tubing whose outer diameter is $\phi 1$ mm.

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**. Continuation ultraviolet-rays (Continuous Wave Ultraviolet : CW UV) laser beam L is irradiated, and a portion to join is made to deposit polymer 3a.

**. -- deposited polymer 3a -- adhesives -- becoming -- configuration storage -- a member 1 and the connection unit 2 are joined in the deposition portion

[0009] Optical CVD is a vapor growth using the luminous energy, and is the forming-membranes method for exciting the electronic state and vibrational state of material gas, and promoting gaseous phase reaction. As the excitation light source of the optical CVD used for this invention, although laser, a lamp, etc. can be used, power density of laser is high and it is the desirable excitation light source at the point that a beam diameter can be extracted to μ m grade. Polymer can be made to deposit by using the ultraviolet radiation which is the wavelength which material gas tended to absorb at high speed, as the above-mentioned operation described especially. Furthermore, it is desirable to use the laser beam by the continuous oscillation which causes a reaction more efficiently than pulse laser light. as the laser equipment which may output a continuation ultraviolet-rays laser beam -- intra -- Ar⁺ of the second harmonic using cavity nonlinear optics Laser equipment, the YAG laser equipment of the fourth higher harmonic, etc. are mentioned.

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[0011] It is the desirable conditions for making polymer deposit more at high speed to cool a portion to join to the low temperature which material gas can condense. As long as the cooling method is the method of cooling the part which means junction at least, it may be what method. For example, the method of maintaining the whole inside of a sealing tub for enforcing optical CVD at low temperature, the method of maintaining only joint grade at low temperature locally, etc. are mentioned. Since the Peltier element is especially arranged near the joint grade and temperature control can do the method of cooling only joint grade locally simply, it is desirable.

[0012] In this example, as a result of making it deposit on a part for a joint as polyvinyl acetate and investigating change of the temperature for a joint, and the rate of sedimentation by the laser power of a continuation ultraviolet-rays laser beam, using vinyl acetate as material gas, when 257nm and a laser power used the laser whose wavelength the temperature for a joint is 25mW at 6.5 degrees C, the maximum rate of sedimentation of about 10 micrometer/min was obtained. Moreover, when the intensity of junction to the configuration storage member and connection unit which were joined in this example was investigated, it turns out that it is possible to bear the force of the shaft orientations of maximum abbreviation 70mN.

[0013] Example 2 this example shows the example in the case of applying this invention to the assembly when giving other active crookedness mechanisms to a catheter. Drawing 2 is drawing in which it is typically shown like the erector of that. The active crookedness mechanism shown in this drawing is made into the structure where three wires for for the first time in [neck] are prepared in the circumference of a catheter, and do not pull these three wires for for the first time in [neck] directly from an operation side, but a wire is pulled by shrinking the configuration storage member made to intervene in between from an operation side in order to make the point of a catheter crooked free. this example is an example which joined this wire for for the first time in [neck], and the configuration storage member at the end. That is, the above-mentioned example is the junction which connects a line and a line with a detailed this example at the end to being three-dimensional junction in the minute portion of a field and a line.

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[0015] Although the junction method of this invention can be used as the general junction method, when the parts which should be joined are minute parts which constitute a micro machine, the usefulness is most notably shown like this example.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing one example of the junction method of this invention typically, and is shown as like [a part of] the assembler when giving an active incurvation mechanism to a catheter.

[Drawing 2] It is drawing showing other examples of the junction method of this invention typically.

[Description of Notations]

- 1 Parts Which Should be Joined (Configuration Storage Member)
- 2 Parts Which Should be Joined (Connection Unit)
- 3 Material Gas
- 3a Polymer
- 4 Peltier Element

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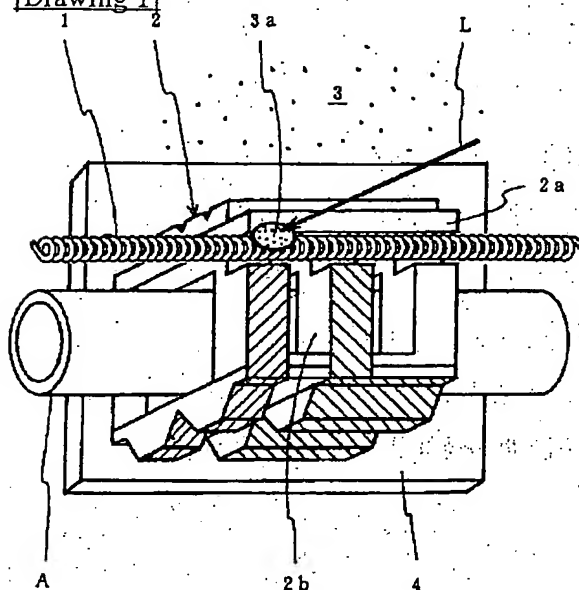
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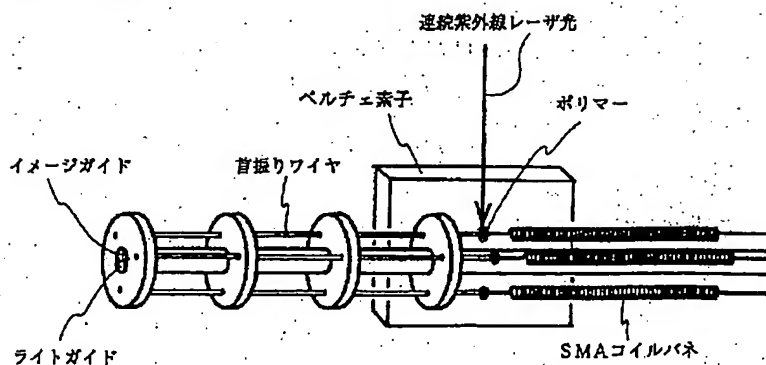
DRAWINGS

[Drawing 1]



- 1 接合すべき部品 (形状記憶部材)
- 2 接合すべき部品 (接座ユニット)
- 3 原料ガス
- 3 a ポリマー
- 4 ベルチエ素子

[Drawing 2]



[Translation done.]